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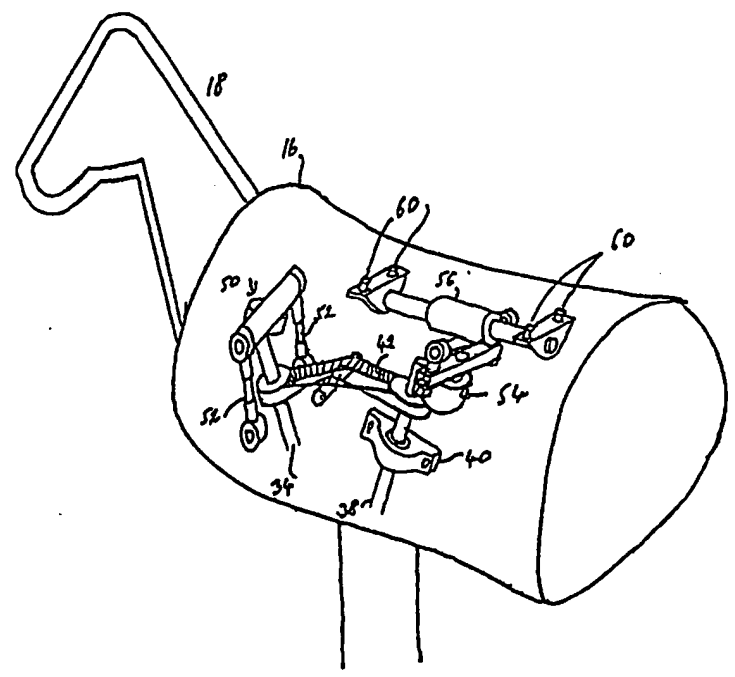
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## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<b>(21) International Application Number:</b> PCT/GB98/00195 <b>(22) International Filing Date:</b> 22 January 1998 (22.01.98)  <b>(30) Priority Data:</b> 9701279.3                      22 January 1997 (22.01.97)                      GB  <b>(71) Applicant (for all designated States except US):</b> BRUNEL UNIVERSITY [GB/GB]; Uxbridge, Middlesex UB8 3PH (GB).  <b>(72) Inventors; and</b> <b>(75) Inventors/Applicants (for US only):</b> CHAPMAN, Christopher [GB/GB]; Brunel University, Uxbridge, Middlesex UB8 3PH (GB). BURKITT, John [GB/GB]; Brunel University, Uxbridge, Middlesex UB8 3PH (GB). SANDBACH, David, Lee [GB/GB]; Brunel University, Uxbridge, Middlesex UB8 3PH (GB).		<b>(81) Designated States:</b> CA, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).  <b>Published</b> <i>With international search report.</i> <i>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>
<b>(54) Title:</b> ACTIVE BALANCE APPARATUS    <b>(57) Abstract</b>  An active balance device (10) comprises a saddle (16) which is moved by a single motor (24) in pitch, yaw and roll. A pair of rotatable shafts (34, 38) are disposed at an angle to the vertical and are coupled to offset bearing mountings (50, 54), as a result of which, during rotation of the shafts (34, 38) pitch and yawing motions are imparted to the seat. Roll is produced by a bent rod (62) in one of the bearing mountings (50).		

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ACTIVE BALANCE APPARATUS

The present invention relates to active balance apparatus able to mimic the movement of a horse's back while it walks.

It is known that horse riding has beneficial therapeutic  
5 effects, particularly to help recovery from some physical injuries and for assistance for some disabilities including Cerebral Palsy, spinal injuries and the like. Riding a horse produces pelvic movements in the rider which imitate those produced during walking, which can tone back muscles  
10 and other important body muscle groups, and which promote the ability to balance.

However, it is not always possible to provide horse riding either because it may not be practical or readily available  
15 or because the person's physical condition may be too poor to be able to cope with a moving horse. Moreover, different horses move in different ways, thereby not necessarily providing the same effects.

20 Many attempts have been made to reproduce the movement of a horse's back mechanically, by what are known as mechanical or rocking horses. However, it is difficult to reproduce accurately the same three dimensional movement of a horse's back, as a result of which many mechanical devices produce a  
25 much simplified approximation in just one or two planes of movement. Movement in more planes has involved the use of many motors, making the system complex and expensive.

The present invention seeks to provide an improved active  
30 balance system.

According to an aspect of the present invention, there is provided active balance apparatus comprising a seat coupled to a driving platform, the driving platform including a  
5 moving mechanism comprising one or two motors operable to move the seat in three planes of movement.

The preferred three planes of movement are pitch, yaw and roll.

10

Preferably, the moving mechanism comprises pitch means, yaw means and roll means for providing pitch, yaw and roll movements, said means being coupled to a common driving motor.

15

In an alternative embodiment, the moving mechanism comprises pitch means, yaw means and roll means for providing pitch, yaw and roll movements, two of said means being coupled to a common driving motor, the third means being coupled to a  
20 separate driving motor.

In one embodiment, the pitch means and yaw means are coupled to the common motor, with the roll means being driven independently. In an alternative embodiment, the pitch  
25 means and roll means are coupled to the common motor, with the yaw means being driven independently.

Advantageously, the moving mechanism includes first and second drive shafts and a common motor coupled to both  
30 shafts, each shaft being provided with coupling means to couple the shafts movably to the seat, wherein pitch and yaw

movements of the seat can be produced by actuation of the shafts.

In the preferred embodiment, each coupling means includes a  
5 coupling bearing coupling the shaft to the seat, the bearing being axially offset relative to its associated shaft.

The offset nature of the bearings provides an off-centre movement of the seat relative to each shaft and as a result  
10 a yawing motion of the seat.

Advantageously, the first and second shafts are disposed at an angle to one another, preferably an acute angle. This feature, when coupled to the offset nature of the bearings  
15 provides the pitching movement of the seat.

The first and second shafts are preferably drivably coupled to one another by means of a flexible drive belt. In order to drive the shafts when they are at an angle to one  
20 another, there may be provided belt redirecting means operable to bend the belt so that it couples to each shaft in a direction substantially perpendicular thereto.

The use of a flexible belt considerably reduces complexity  
25 of the assembly and therefore cost. It also allows for coordinated rotation of the two shafts. The redirecting means, which may simply be a rod or the like over which the belt slides, ensures proper positioning and operation of the belt and also allows for adjustment to the positions of the  
30 shafts relative to one another and thereby adjustment of the nature and amount of movement.

In the preferred embodiment, one of the two bearings is coupled to the seat through a bent shaft. As the bearing rotates, so does the bent shaft. The angle of bend imparts  
5 a rolling motion to the seat and therefore movement in the third plane.

The seat is preferably attached to the moving mechanism through resilient couplings. This provides a certain amount  
10 of play in the assembly and enables the seat to be moved, for example rocked, slightly by hand, thereby giving a natural feel to the device. Moreover, the resilient couplings causes the various types of movement to combine with one another and prevents sharp changes from a pitching  
15 movement to a yawing movement and so on. It also eases changes in direction of movement.

According to another aspect of the present invention, there is provided a horse simulator comprising a movable seat and  
20 means for generating yaw movements in the seat including first and second shafts each coupled to the seat by an offset bearing. Preferably, the first and second shafts are coupled to one another by a flexible drive belt.

25 Advantageously, the first and second shafts are disposed at an angle to one another, thereby to provide pitching movements of the seat.

According to another aspect of the present invention, there  
30 is provided a horse simulator comprising a movable seat and means for generating roll movements in the seat including a

5

shaft coupled to the seat by an offset bearing, the offset bearing including a non-linear coupling member between the bearing and the seat. The non-linear member produces a rolling motion on rotation of the shaft.

5

An embodiment of the present invention is described below, by way of example only, with reference to the accompanying drawings, in which:

- 10 Figure 1 is a perspective view of a preferred embodiment of active balance apparatus;

Figures 2a to 2c are different elevational views of an example of cowlings for the apparatus of Figure 1;

15

Figure 3 is a schematic diagram of a first part of an embodiment of saddle movement mechanism;

- Figure 4 is a more detailed view of the mechanism of Figure  
20 3;

Figure 5 is a view of bearing couplings of the mechanism of Figures 3 and 4;

- 25 Figures 6 and 7 are detailed views of respective bearing couplings of Figure 5;

Figures 8a and 8b show alternative embodiments of roll generating mechanisms; and

30



Figure 9 shows various details of a decorative head mounting for the apparatus of Figure 1.

Referring to Figure 1, the embodiment of active balance apparatus 10 shown includes a base 12 provided with four support legs 14 and covered by a cowling. Movably supported on the base 12 is a seat assembly 16 which in this embodiment is in the shape of a horse saddle. Coupled to the saddle 16 is a decorative head portion 18 described in further detail below in connection with Figure 8.

Within the base 12 and the saddle assembly 16 there are provided various mechanical and electrical mechanisms for moving the saddle 16 in a manner which imitates the movement of a saddle on a horse's back during riding. For this purpose, the saddle 16 is moved in pitch, yaw and roll, as is described in detail below.

Various elevational views of the cowling of base 12 are shown in Figures 2a to 2c, which need not be described in detail save to say that it is intended to cover the mechanical and electrical components of the moving mechanism described below and that it is designed to prevent accidental injury during use of the apparatus.

25

Figures 3 and 5 show in schematic form a first part of the moving mechanism 20 located within the base 12. Secured to the legs 14 is a support member 22 on which is mounted an electric motor 24 which in the preferred embodiment is the only motor in the apparatus.

The output of the of the motor 24 is coupled through a bearing assembly 26 forming part of a rack and pinion mechanism 28, in which the rack 30 is reciprocally movable on driving of the motor. The pinion 32 is provided at the lower end of a first driving shaft 34.

The first driving shaft 34 is disposed at a predetermined angle to the vertical and is rotatably supported in this position by suitable support struts connected to the support member 22, of which only a bearing coupling 36 is shown in the drawings. Located at the upper end of the first drive shaft 34 is a bearing coupling which is secured to the inner wall of the saddle 16 as is described below.

A second shaft 38 is also disposed at an angle to the vertical and points away from the first drive shaft 34. This second shaft 38 is also rotatably supported in this position by suitable support struts connected to the support member 22, of which only a bearing coupling 40 is shown in the drawings. The upper end of the second drive shaft 38 is also provided with a bearing coupling which is secured to the inner wall of the saddle 16 as is described below.

The second shaft 38 is driven by the first drive shaft 34 through a flexible belt 42 coupling the two. In order to take into account the different orientations of the shafts 34, 38, the belt 42 is passed over and bent by a rod 44 or other rounded surface. This configuration of belt and bending member 44 avoids significant complexity and cost which would be involved with a gear mechanism.

It will be apparent from Figure 5 in particular that the rack 30 will reciprocate in the directions of the arrow on actuation of the motor 24. This will cause the first drive shaft 34 to rotate in both axial directions. In order to  
5 control the amount of rotation of the first shaft 34 and, as will become apparent from the ensuing description, movement of the saddle 16, the pinion 32 is chosen so as to provide, in this example, around 300° of rotation. The belt 42 is toothed and is coupled to the shafts 34, 38 by toothed gears  
10 46 arranged such that the second shaft 38 rotates a total of over 360° for 300° rotation of the first shaft 34.

Referring to Figures 4 and 5, at the upper end of the first drive shaft 34 there is provided a first bearing mount 50  
15 which includes an offset bearing, described below, and a pair of struts 52 pivotably coupled at respective sides of the bearing mount 50. The lower end of the struts 52 are pivotably secured to the inner surface of the saddle 16, preferably through a resilient mount such as a rubber mount.  
20 The use of a resilient mount provides a small amount of flexibility in the way of play to the saddle assembly 16 to give it a more natural feel.

The upper end of the second shaft 38 is also provided with a  
25 bearing mount 54, described in detail below, which is connected to a sliding bearing 56 having a shaft 58 secured to the inner surface of the saddle 16. The shaft 16 is also secured by means of resilient mounts 60.

The first bearing mount 50 is shown in more detail in Figure 6, which is a mirror image relative to Figures 4 and 5. The shaft 34 is connected by means of a spacer 60 to a rod 62 which is thus offset relative to the axis of the shaft 34.

5 The upper end of the rod 62 has a bearing to which the strut 52 is coupled. A cup housing 64 is located around the rod 62 and is sufficiently large to allow rocking of the strut 52. The lower end of the strut 52 is provided with another bearing 66 which connects with the resilient mount.

10

As will be apparent from Figure 6, the rod 62 is bent at 68 so as to be in a non-parallel axis relative to the drive shaft 34.

15 The second bearing mount 54, shown in detail in Figure 7, is also offset relative to the second shaft 38 by means of a spacer (not shown), as will be apparent from Figure 5. The spacer is connected to a lower bearing member 70 within which a rod 72 is rotatably disposed. The rod 72 extends

20 along an axis substantially parallel to the axis of the second shaft 38.

At the upper end of rod 72 there is provided a bearing 74 to which is coupled the sliding bearing assembly 56, 58.

25

In operation, when the motor 24 is activated, the rack 30 will reciprocate causing the shaft 34 to rotate in both directions over a total angle of rotation of, in this example, 300°. The belt 42 causes the second shaft 38 to

30 rotate over a total angle of rotation of, in this example,

over 360°. As a result of the offset bearing mount 50, the rotation imparted to the front of the saddle 16 will not be purely rotational. There will be a component of yaw related to the horizontal component of rotation of the shaft 34 and  
5 a component of pitch caused by the non-horizontal components of the rotation of the shaft 34. The yaw motion produced at the front of the saddle 16 is shown to the left of Figure 6 and is part circular.

10 Forward motion of the saddle 16 is basically produced by the front assembly 34-50, with the sliding bearing 56-58 providing basically a slave behaviour in this regard.

The second shaft 38 and associated bearing mount 54 produces  
15 a yaw motion at the back of the saddle 16 as shown to the left of Figure 7. This motion, in combination with that at the front of the saddle 16 mimics the motion of a saddle on the back of a horse.

20 Roll is produced as a result of the bent rod 62 in the front bearing mount 50. As will be apparent from a consideration of Figure 6, as the shaft 34 rotates, the bearing 50 rotates also, causing the strut 52 to rock from one side to the other during each rotation. By virtue of the coupling to  
25 the saddle 16, roll of the saddle is generated. The amount of roll depends on the angle of bend in the rod 62, which can therefore be chosen to suit the particular need. However, in the preferred embodiment, the amount of roll is chosen to be equivalent to that of a typical horse.

Thus, by simple mechanical components, the saddle can be made to pitch, yaw and roll. The integration of the movements into the same mechanical components ensures that there is not separate change from one type of movement to  
5 another. Rather, a pitching movement will combine with yawing and/or roll in the same way as would occur on a horse.

The amount of pitch and yaw can be changed by changing, for  
10 example the angle of inclination of one or both of the shafts 34, 38, as desired. For this purpose, they may be mounted to the support member 22 by means of an adjustable mount. The flexible belt 42 can readily accommodate such changes in angles of the shafts 34, 38.

15

Similarly, the angle of roll can be changed, for example, by replacing the rod 62 with one having a different angle of bend. Alternatively, the rod 62 could be replaced by a two part mechanism in which each part replaces the upper or  
20 lower part of the rod 62, respectively, and in which they are pivotably or otherwise adjustably connected together.

In an alternative embodiment, the front bearing mount 50 provided a coupling to the saddle which allows for  
25 independent roll and the rod 62 is replaced by a straight rod. Roll is generated by a separate mechanism, such as one of the ones shown in Figures 8a or 8b.

Referring to Figure 8a, the saddle 16 is shown in transverse  
30 cross-section and the mechanism shown in figures 3 to 7 shown simply as a box 20. Roll is provided by means of a

shaft 92 coupled to one side of the saddle 16 and reciprocable into and out of a piston 90 driven by a suitable motor 94. It will be apparent that the motor 94 will be controlled in conjunction with the motor 24 so as to  
5 provide appropriate roll.

In Figure 8b the piston assembly 90, 92 is replaced by two air bags 100 102 either side of the saddle 16. A suitable pneumatic hydraulic pump 104 inflates and deflates the bags  
10 100, 102 to generate roll. The pump 104 will be controlled in conjunction with the motor 24 so as to provide appropriate roll.

In an alternative embodiment, the second shaft 38 could be  
15 driven by its own motor.

Figure 9 shows an example of ornamental horse head 200, which is particularly useful with children. The head 200 is formed from metal tubing 202 to which are attached a mane  
20 204 and a pair of ears 206, preferably in leather. The head 200 can be attached to the saddle 16 by suitable decorated fasteners 208.

It is envisaged that reins will also be provided for  
25 assisting in balancing, and stirrups when appropriate.

In the preferred embodiment, the seat 16 has a variable shape in order to accommodate different user needs. For this purpose, the seat 16 is provided with pockets (not  
30 shown) either side thereof into which one or more pads may

be inserted. It is envisaged that in some circumstances the seat shape may not be symmetrical.

Additionally or alternatively, the seat 16 may be formed in  
5 two halves connected by a longitudinal hinge.



## CLAIMS

1. Active balance apparatus comprising a seat coupled to a driving platform, the driving platform including a moving  
5 mechanism comprising one or two motors operable to move the seat in three planes of movement.
2. Active balance apparatus according to claim 1, wherein the three planes of movement are pitch, yaw and roll.
- 10 3. Active balance apparatus according to claim 1 or 2, wherein the moving mechanism comprises pitch means, yaw means and roll means for providing pitch, yaw and roll movements, said means being coupled to a common driving  
15 motor.
4. Active balance apparatus according to claim 1 or 2, wherein the moving mechanism comprises pitch means, yaw means and roll means for providing pitch, yaw and roll  
20 movements, two of said means being coupled to a common driving motor, the third means being coupled to a separate driving motor.
5. Active balance apparatus according to claim 4, wherein  
25 the pitch means and yaw means are coupled to the common motor, with the roll means being driven independently.
6. Active balance apparatus according to claim 4, wherein the pitch means and roll means are coupled to the common  
30 motor, with the yaw means being driven independently.

7. Active balance apparatus according to any preceding claim, wherein the moving mechanism includes first and second drive shafts and a common motor coupled to both shafts, each shaft being provided with coupling means to  
5 couple the shafts movably to the seat, wherein pitch and yaw movements of the seat can be produced by actuation of the shafts.

8. Active balance apparatus according to claim 7, wherein  
10 each coupling means includes a coupling bearing coupling the shaft to the seat, the bearing being axially offset relative to its associated shaft.

9. Active balance apparatus according to claim 8, wherein  
15 one of the two bearings is coupled to the seat through a bent rod.

10. Active balance apparatus according to claim 7, 8 or 9, wherein the first and second shafts are disposed at an angle  
20 to one another.

11. Active balance apparatus according to any one of claims 7 to 10, wherein the first and second shafts are drivably coupled to one another by means of a flexible drive belt.  
25

12. Active balance apparatus according to claim 11, including belt redirecting means operable to bend the belt.

13. Active balance apparatus according to any preceding  
30 claim, wherein the seat is attached to the moving mechanism through resilient couplings.

14. Active balance apparatus substantially as herein described with reference to the accompanying drawings.

5 15. A horse simulator comprising a movable seat and means for generating yaw movements in the seat including first and second shafts each coupled to the seat by an offset bearing.

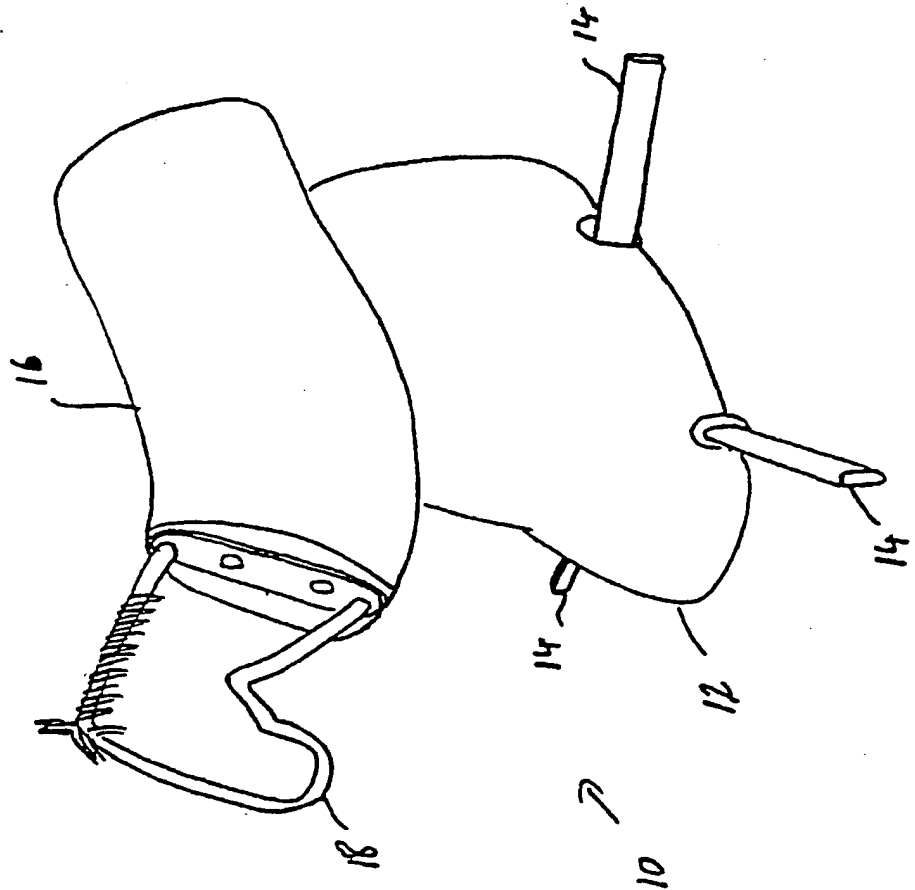
16. A horse simulator according to claim 15, wherein the  
10 first and second shafts are coupled to one another by a flexible drive belt.

17. A horse simulator according to claim 15 or 16, wherein the first and second shafts are disposed at an angle to one  
15 another, thereby to provide pitching movements of the seat.

18. A horse simulator comprising a movable seat and means for generating roll movements in the seat including a shaft coupled to the seat by an offset bearing, the offset bearing  
20 including a non-linear coupling member between the bearing and the seat.

19. A horse simulator substantially as herein described with reference to the accompanying drawings.

Fig. 1



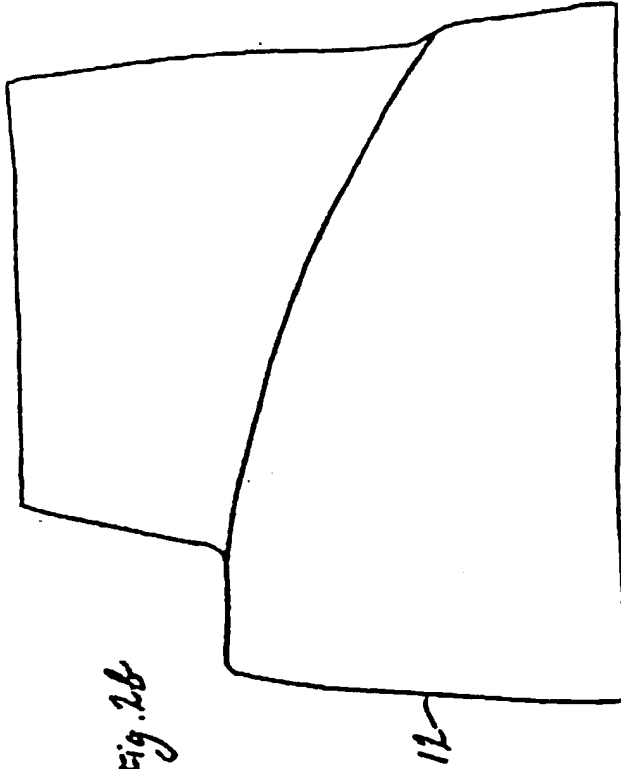


Fig. 2b

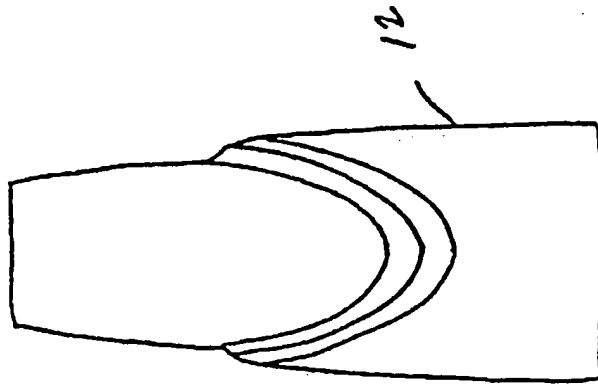


Fig. 2a

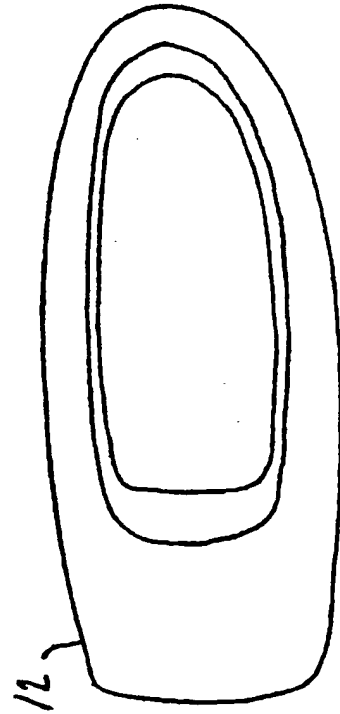


Fig. 2c

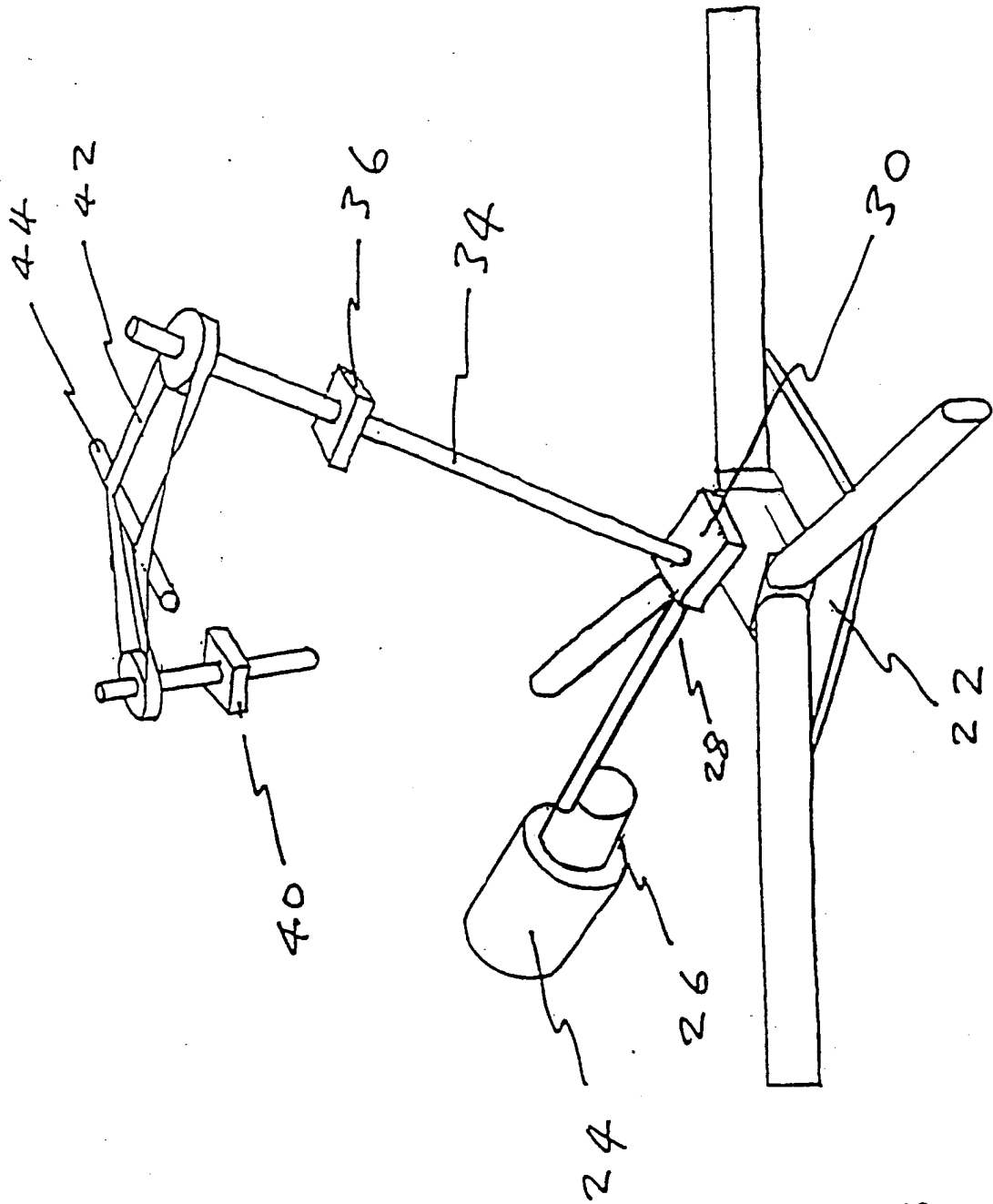
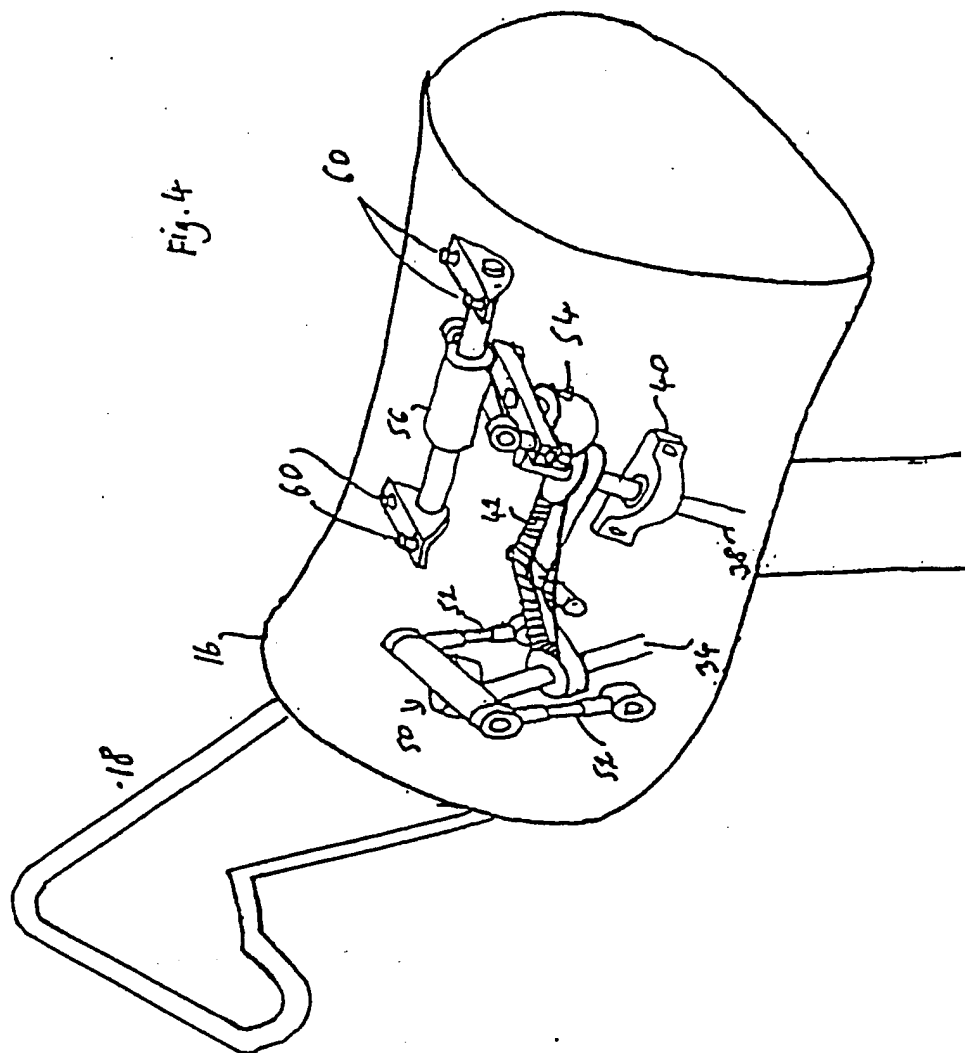


Fig 3



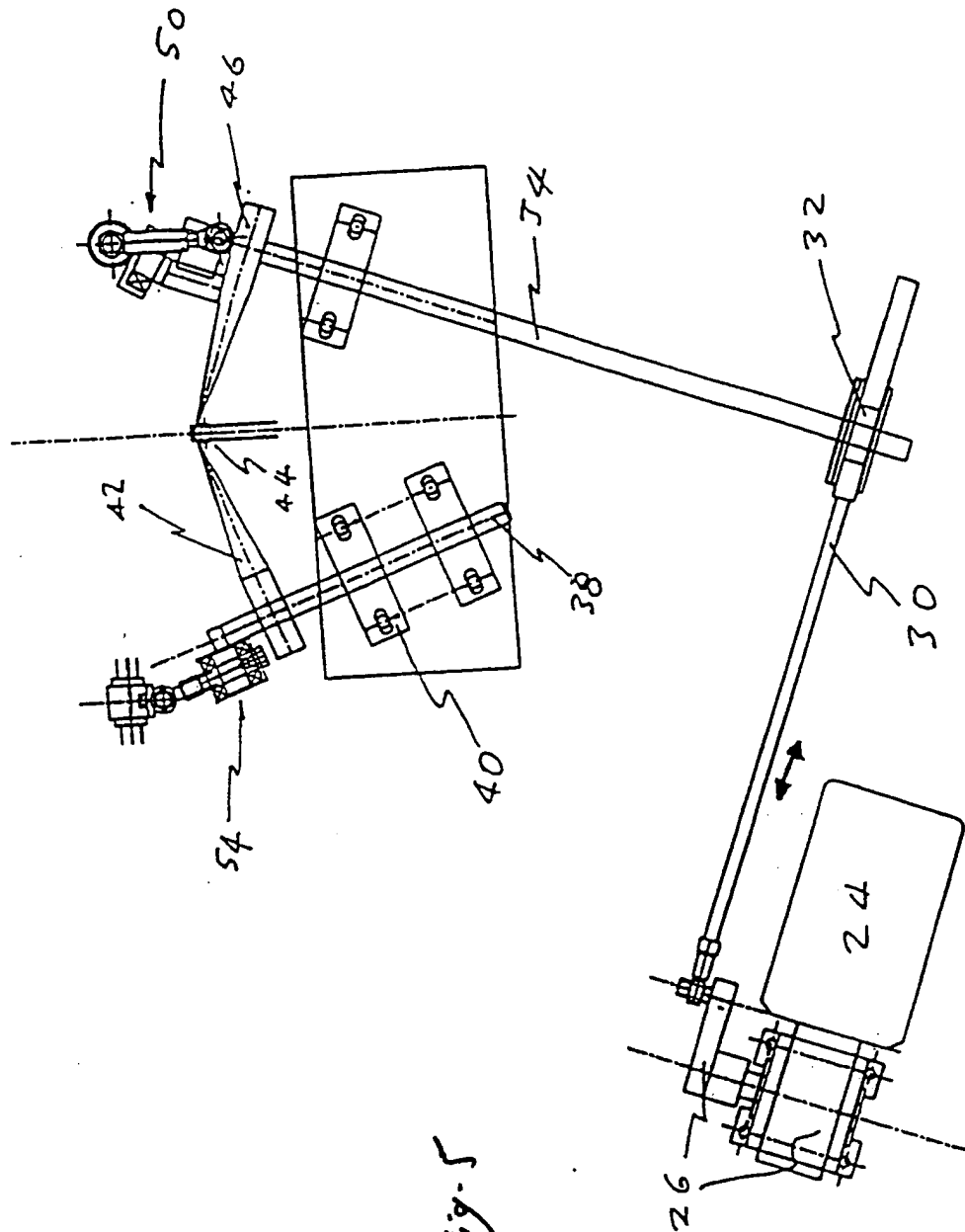
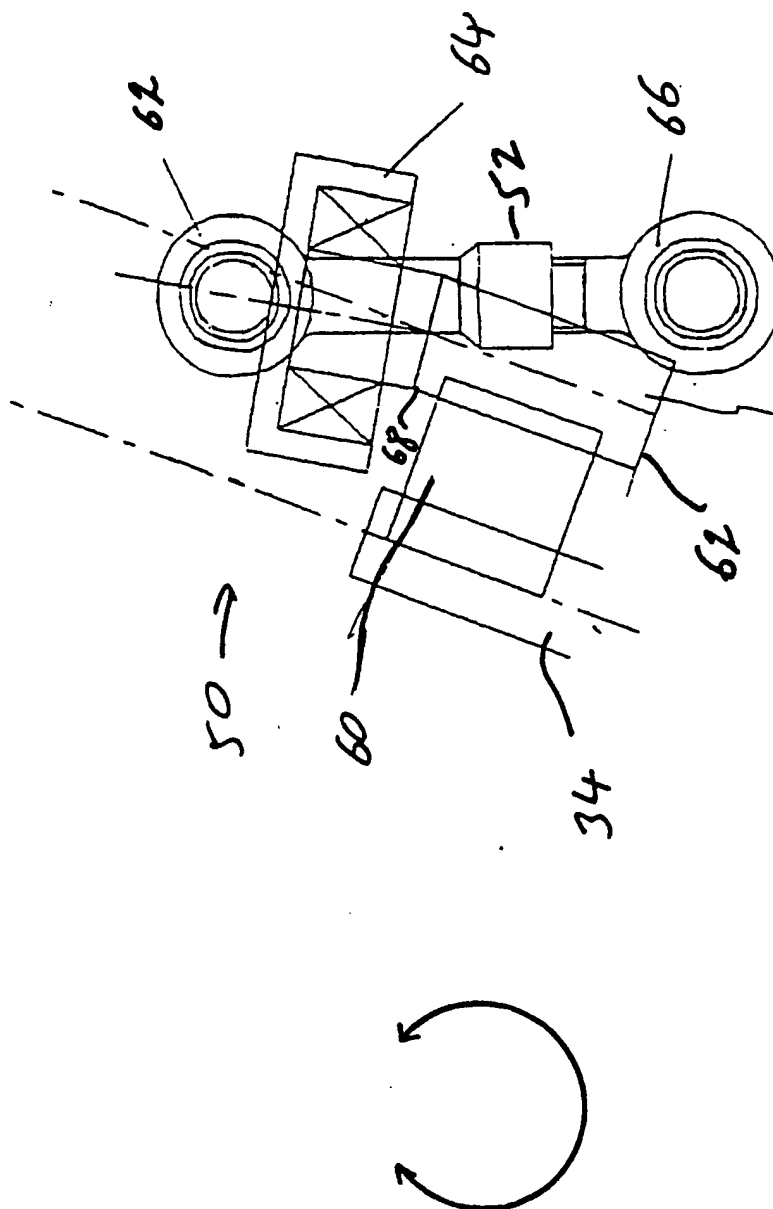
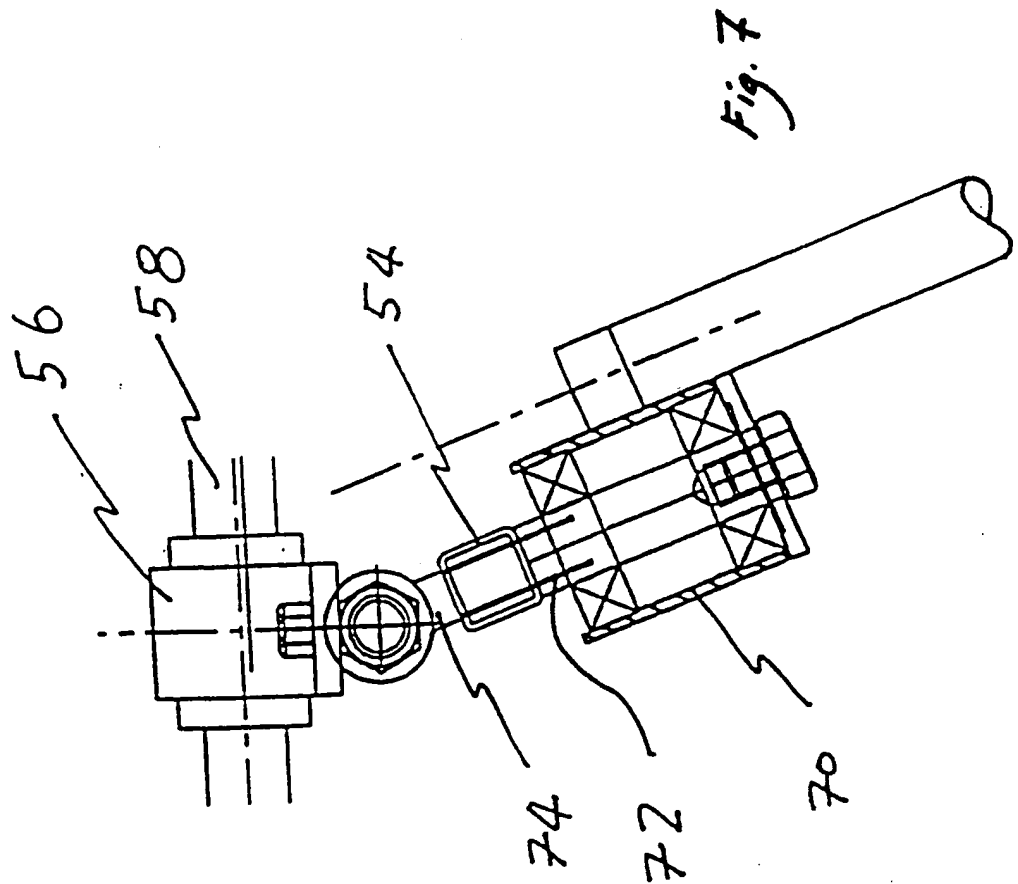


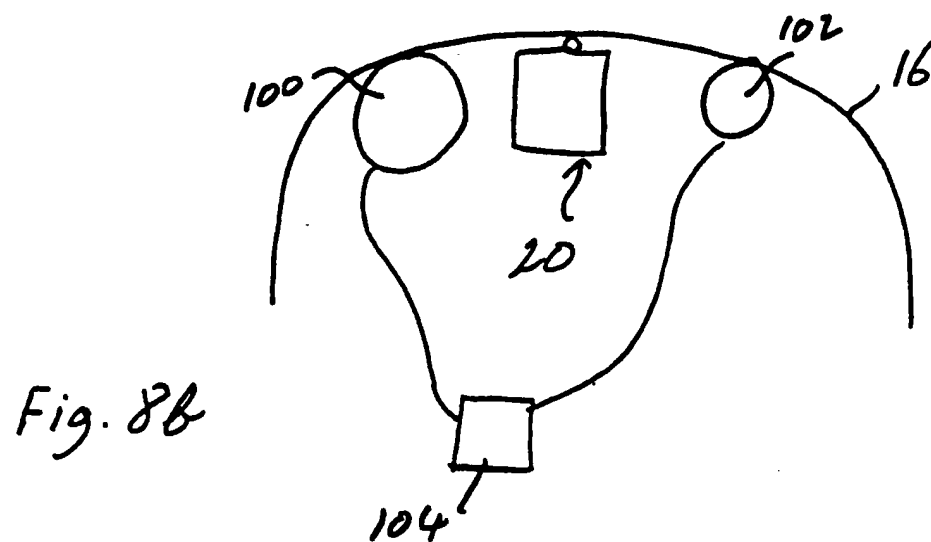
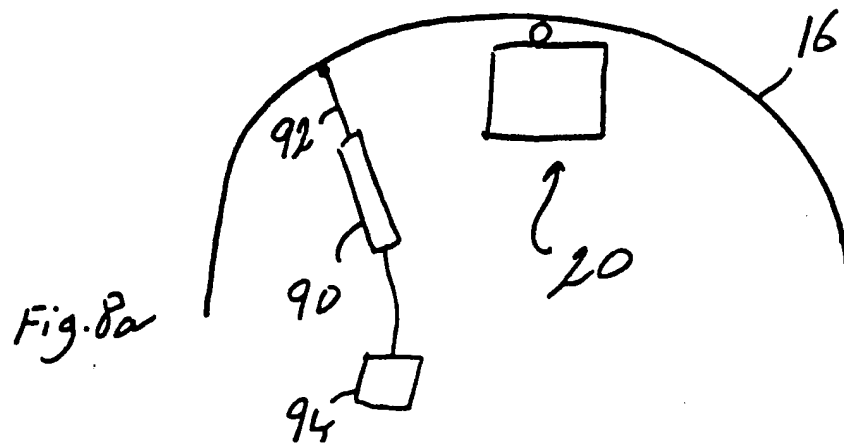
Fig. 5

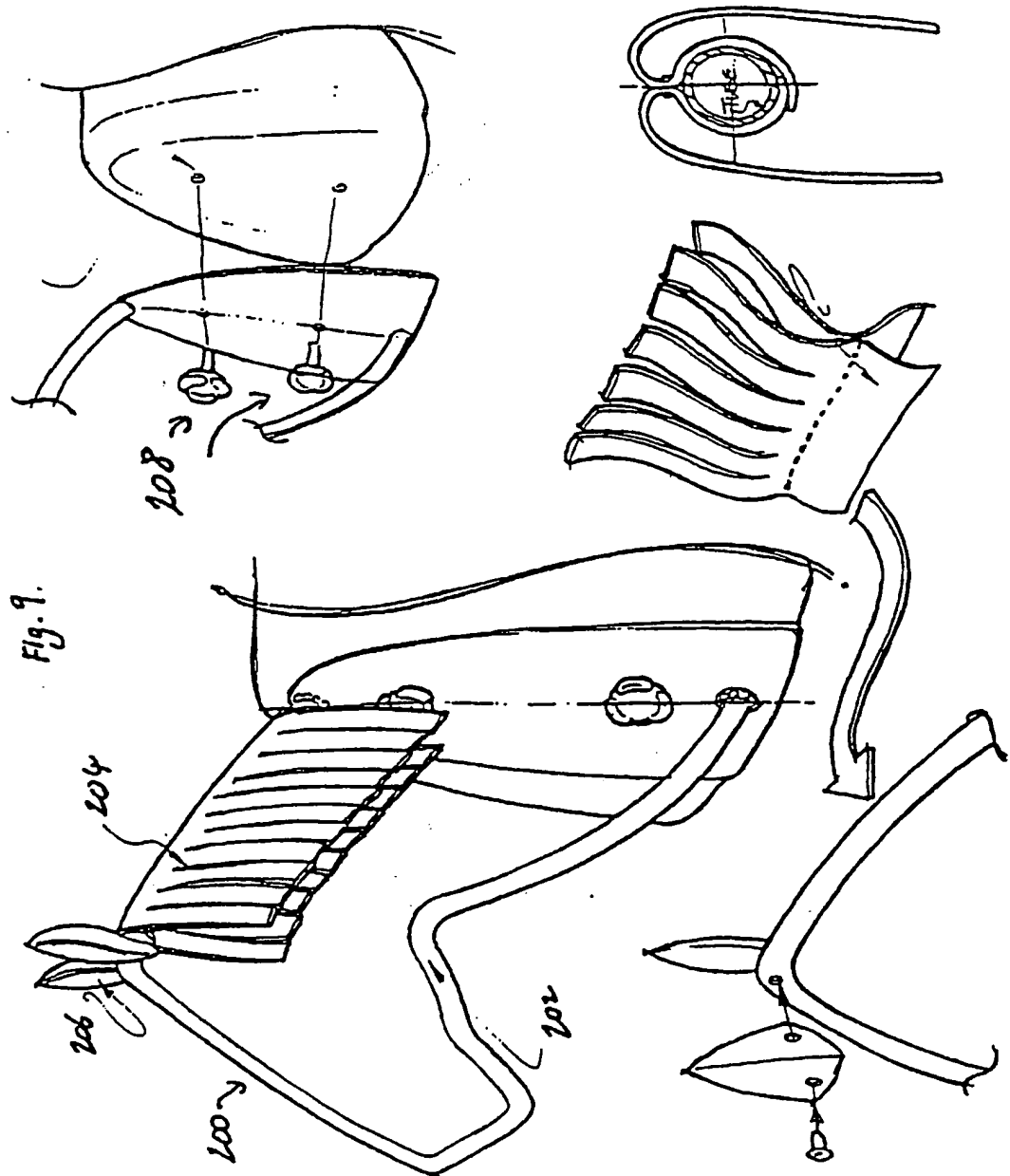


Fig. 6









# INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 98/00195

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 6 A63B69/04

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 A63B A63G

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**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 988 300 A (YAMAGUCHI MASAOKI ET AL) 29 January 1991 see column 8, line 45 - column 9, line 18; figures 1-27	1-3, 15, 17, 18
A	EP 0 407 158 A (COLLINS CHARLES SEAN) 9 January 1991 see column 5, line 8 - column 6, line 9; claims 1,6; figures 1-8	1, 15, 18
A	US RE22105 E (MARLOWE) 2 June 1942  see page 2, right-hand column, line 32 - page 3, right-hand column, line 26; figures 1-10	1, 2, 15, 18

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US RE22105     E		NONE		
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